radially, and that no mesenteries have been seen." Mr. Moseley was naturally dissatisfied with these poor results, and hoped to do better things at Hawaii. In the meantime I became aware of the value of the drawings I have already alluded to, and as I am at work on several subjects with Gen. Nelson, I sent a communication and the drawings to the "Annals and Magazine of Natural History" before the evening of April 6, when Mr. Moseley's paper on Millepora was heard by me at the Royal Society. It is a satisfaction for me to be able to state that Gen. Nelson's drawings prove that Agassiz saw a part of a polype, and that Mr. Moseley's beautiful delineations, far in advance of all, testify to the correctness of my fellow-worker. I do not credit the hydroid nature of the polyp now, any more than I did when writing the reports on the British fossil corals, and I believe Millepora to be an Actinozoan.

P. MARTIN DUNCAN

The Use of the Words "Weight" and "Mass"

THE relations between weight and mass, gravity and acceleration, are so well defined in all good treatises on dynamics, that it appears superfluous to dwell on these questions. But as it has been stated by Prof. Barrett, vol. xiii., p. 385, that the C. G. S. system of units has been introduced into the course of Mechanics in this College, I may be permitted to say that the system actually employed is not that referred to by your correspondent. I generally employ the kilogramme, metre, and second, and sometimes the foot, pound, and second, to measure a dynam or unit of force. The dynamometers alluded to as about to be exhibited at the Loan Exhibition of Scientific Instruments at South Kensington are suitable to the former system, and I use them for the measurement of dynams in kilogrammetres. One of these dynamometers is graduated for every 200 grammes up to 100 kilogrammes, the other for every 100 grammes up to 10 kilogrammes, and they cannot be depended on for results within the tenth of a kilogramme. Spring dynamometers, though suitable for the large units employed in mechanics, are totally unfit for measuring units on the C. G. S. system. I concur with Prof. Everett, in his book on this system, when he says:—"A spring balance, it is true, gives a direct measurement of force, but its indications are too rough for purposes of accuracy" (p. 8). Spring dynamometers are therefore unsuited to a system where the units are measured by $\frac{1}{981}$ of a gramme, or about $\frac{1}{63}$ of a grain, as in the C. G. S. system.

HENRY HENNESSY

Royal College of Science for Ireland, Dublin

The Physical Constitution of Steam

I BELIEVE the following remarks on the physical constitution of steam are in some degree original, in form at least, though perhaps not in substance.

Dr. Andrews has shown by his experimental researches on carbonic acid, that at a temperature above 31° C. or 88° F. the difference between the gaseous and the liquid states no longer exists. I quote the following brief statement from an admirable paper on the subject, by Prof. James Thomson, in the "Proceedings of the Belfast Natural History and Philosophical Society," 1872;—he is speaking of the case in which a given quantity of carbonic acid, of which part is in the gaseous and part in the liquid state, is kept at constant volume, while the temperature, and consequently the pressure, are gradually increased:—

"As the temperature and pressure are augmented, the gaseous part is always increasing in density, and the liquid part is diminishing in density, till at last the two come to have the same density with one another, and then they are perfectly alike in every respect, all distinction between them having vanished. At this stage the temperature is 31° C., and the pressure is about seventy-five atmospheres. Above this temperature of 31° no change of pressure can cause gasification or liquefaction; and above this pressure of about seventy-five atmospheres, no change of temperature can cause gasification or liquefaction."

This temperature of 31° C. is called by Dr. Andrews the critical temperature for carbonic acid. Above its critical temperature, although carbonic acid may have the density either of a gas or of a liquid, the two states are not sharply separated from each other as a liquid is from its vapour, but graduate into each other insensibly. It is believed that every gas and vapour has its own critical temperature. Those of the permanent gases are believed to be so low as to be unattainable by any known process. That of water or steam, on the contrary, is probably too high to be observed in a glass tube, and consequently too high to be directly observed at all: for the only known test of the critical temperature being attained, consists in the disappearance of the visible boundary surface between the liquid and the vapour or gas. My purpose is to show how the critical temperature for steam may be approximately estimated with a great degree of probability.

The fact that the latent heat of steam diminishes as the temperature increases, formerly seemed to me one of the strangest of all facts; but the above-mentioned properties of carbonic acid, and no doubt of all gases and vapours, make it quite intelligible.

The *latent heat* is defined as the heat given out when steam is condensed into water of its own temperature. The *total heat* is defined as the heat given out when steam is condensed into water at zero Centigrade, and is the sum of the latent heat and the temperature. According to Regnault, the relation between temperature and total heat is expressed by the formula—

$$\lambda = 606{\cdot}5 + {\cdot}305\, t.$$

λ being the total heat and t the temperature. This has been ascertained to be true from 0° to 230°, and if it is true for all temperatures, at a temperature of 872·7 the total heat and the temperature would be the same, and the latent heat would vanish: 872·7 is consequently the critical temperature which is deducible from the above formula for water.

Old Forge, Dunmurry,
Co. Antrim

JOSEPH JOHN MURPHY

Coloured Solar Halos

IN the interesting letters of Drs. Schuster and Frankland I note some remarks on the rarity of the apparition of complete halos about the sun in this country. Had I read these remarks some six years ago I should have passed them by without surprise. It so happened, however, that my attention was drawn to the subject of halos, coronas, &c., by Kämtz's "Lehrbuch der Meteorologie" about the year 1869, and I at once began to examine the sky near the sun every fine day, and note down any appearance of halos, fringes, &c. When I began, my impression was that I should rarely see the solar halo seeing that it had escaped me for several years. However, I soon found out my mistake, and the subjoined list, compiled from the observatory note-books, gives the number seen each month in 1874 and 1875. No doubt, several escaped my vigilance in some months and a few in others. The figures, at any rate, show that the phenomenon is by no means rare.

Solar Halos in 1874 *and* 1875.

	1874.	1875.		1874.	1875.
Jan.	0	2	July	3	4
Feb.	1	2	Aug.[1]	1	—
March	1	2	Sept.	2	4
April	11	4	Oct.	0	2
May	8	1	Nov.	3	0
June	11	2	Dec.	1	0

	Jan.	Feb.	March.
1876	1	0	8

Had I been quite sure that Dr. Schuster's remarks referred to the ordinary solar halo, this letter would have reached you a week ago or more. I will only add that the halos I have observed are nearly always complete (when the sun is high enough), that they are often very bright and most striking phenomena, and that the radius is usually about 22°.

Bermerside, Halifax, April 6

JOSEPH GLEDHILL

"The Effect of the Sun's Rotation and the Moon's Revolution on the Earth's Magnetism"

THE above was the title of an article by J. Allan Broun, published in NATURE, vol. xiii. p. 328.

The establishment of these facts, if they have not already been published, will aid amateur investigators very much in arriving at satisfactory conclusions in regard to the phenomenon above referred to.

First, from the revolutions of the sun, do the positively defined edges of sunspots always reappear at the same moment, and are their relative positions with regard to each other ever the same through a series of years, giving them a fixed and positive character, both as to position and time of revolution?

Second: At what times, with regard to the position and area of the largest and most numerous sunspots, and whether they are hidden by the revolution of the sun, or face the earth, is the

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[1] I was from home most of this month in both years.

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greatest effect observable in the differences of the earth's magnetism?

Third: Are the sun-spots caused by clouds or curtains outside, and hiding the apparent surface of the sun, or are they deep cavities through the same? STEPHEN W. ALLEN

Boston, U.S.A., March 27

Metachromism

I REFRAIN from replying to Mr. Petrie's second letter (p. 426) until after the appearance of the article to which Mr. Costerus refers (p. 427) on "Organic Colour Change."

In defence of Miller, however, I would just add that on p. 298, vol. ii. (fifth edition), occur the following words:—"The sodic dioxide, Na_2O_2, obtained by igniting sodium in oxygen is of a *pure white colour*." WM. ACKROYD

Royal Coll. of Chemistry, South Kensington, April 3

Dr. Klein on the Small-pox of Sheep

I WRITE this note in order to inform you that, my attention having been directed to some alleged fallacies in some of my observations regarding the small-pox of sheep, I am at present engaged in reinvestigating the subject. E. KLEIN

The Brown Institution, April 11

OUR ASTRONOMICAL COLUMN

OLBERS' SUPPOSED VARIABLE STAR NEAR 53 VIRGINIS.—The only comet detected in the year 1796 was found by Olbers in Virgo on the night of March 31. On the following evening, at 8h. 55m., apparent time at Bremen, it was over a star of the seventh magnitude south—following 53 Virginis, and the light of the star was remarked to be little affected by the intervention of the comet. On March 1, 1797, desiring to fix more exactly the place of this star, Olbers found in its position one of only the tenth or eleventh magnitude, whereas in April previous, according to Schroeter, who appears to have compared the comet with it early on the morning of April 2, it was the brightest star in the immediate neighbourhood of 53 Virginis, and hence in Olbers' judgment "a seventh magnitude at least." Writing to Bode in March 1797 he directs attention to this star, as perhaps a more remarkable variable star than even χ Cygni. The circumstances preclude suspicion of a similar phenomenon to that described by Piazzi when the great comet of 1811 passed over his star XX. 197.

From the positions of the supposed variable, and its neighbours given by Olbers (who also appends a diagram), it is evident that his star, which followed 53 Virginis 30′ 55″ in R.A., 20′ 45″ to the south, is No. 12,728 of Oeltzen's Argelander, a star observed 1851, April 24, and noted of the eighth magnitude. For 1876·0 its place is in R.A. 13h. 7m. 32s., and N.P.D. 105° 53′·7.

Approximate mean places for 1797, March 1, of several stars with which Olbers compared the one in question were:—

	Olbers' Magnitude.	R.A.	N.P.D.
		° ′	° ′
(*c*)	9	194 40	106 6
(*a*)	7	194 44	105 24
(*d*)	11	196 15	105 11

The star (*c*) is Lalande 24,421, called by him 8½; (*d*) is L. 24,597, noted 9; but the star (*a*) is not found either in Lalande or Argelander. Its position in Olbers' diagram corresponds to the place above assigned. What is its present magnitude, or is there some mistake about its position?

On April 1, 1796, the supposed variable was considerably brighter than the star (*a*), according to Olbers; in March 1797, much fainter than (*c*) and only slightly brighter than (*d*); he remarked no change in March, April, and May. Bode says, on April 24 and May 12 and 20 of the same year he saw it as a 9·10. In March 1855 it was fully eighth magnitude or 7·7.

THE APRIL METEORS.—As the moon will be absent during the nights of the 19th and 20th of the present month, a watch may be advantageously kept for meteors which are supposed to move in the path of the first comet of 1861 discovered by Mr. Thatcher, of New York, on April 4. At the descending node this comet makes a remarkably close approach to the earth's annual track, the definitive orbit calculated by Prof. Oppölzer, showing that at this point the distance between the two orbits is only 0·00232 of the earth's mean distance from the sun, or 214,000 miles; less, therefore, than the moon's mean distance from the earth. The elements are elliptical with a revolution of 415 years, and this form of orbit we may assume with much probability to have been occasioned by a near approach of the comet to the earth at some distant epoch. The descending node is passed 22½ days before perihelion passage, and to bring the comet into closest possible proximity to our globe, it is necessary that the perihelion point should be passed on May 12. Had this been the case in 1861, the comet would have occupied the following positions on its descent towards the plane of the ecliptic:—

	R.A.	N.P.D.	Distance from earth.
	°	°	
March 24·0	269·2	57·4	0·700
April 1·0	270·3	57·0	0·494
„ 9·0	271·3	57·1	0·281
„ 17·0	285·2	59·4	0·065

The true dimensions of the orbit of this comet will be defined by the following numbers, which are in units of the earth's mean distance from the sun.

Semi-axis major	55·676
Semi-axis minor	10·083
Semi-parameter	1·826
Perihelion distance	0·921
Aphelion distance	110·430

PROF. HUXLEY'S LECTURES ON THE EVIDENCE AS TO THE ORIGIN OF EXISTING VERTEBRATE ANIMALS[1]

IV.

THE crocodiles form the highest group of existing reptiles; they are higher than lizards as a steam-vessel is higher than a sailing-ship; for, while built essentially on the same lines, and exhibiting altogether the same fundamental structure, they are in some respects peculiarly modified, and that always in the direction of greater complexity.

Besides the characters of the skull mentioned in the last lecture, they are distinguished from lizards by having a four-chambered heart, one in which the separation of the ventricle into two distinct cavities is completed, so that, in the heart itself, the blood from the lungs is kept separate from that returned from the body generally. A mixture, however, takes place subsequently, through an aperture between the two aortæ, one of which springs from each ventricle.

Crocodiles are found in Central America, India, Africa, and Australia. Of the many species, the greater number are short-snouted; the fish-eating Gavial of the Ganges, on the other hand, has an extremely long and narrow snout.

All the existing crocodiles are fresh-water or estuarine animals, but, fortunately, this was not the case with the ancient forms, many of which were exclusively marine, seeming, so to say, to take the place, in the sea of their own epoch, of our porpoises and dolphins.

Besides Tertiary species, crocodiles are found in the Chalk, Oolite, Lias, and Trias often in the best possible state of preservation; they therefore extend back to the very commencement of the Mesozoic epoch.

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[1] A course of six lectures to working men, delivered in the theatre of the Royal School of Mines. Lecture IV., March 20. Continued from p. 430.

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